

CLAIMS

1. An FRP structural material having a core material and an FRP skin layer disposed on at least one surface of said core material, characterized in that a plurality of core materials are stacked in the thickness direction.
2. The FRP structural material according to claim 1, wherein said FRP structural material has a portion where core materials are directly stacked onto each other.
3. The FRP structural material according to claim 1 or 2, wherein said FRP structural material has a portion where an FRP skin layer is interposed between stacked core materials.
4. The FRP structural material according to any of claims 1 to 3, wherein a stacked body of said core materials has a curved surface on at least a part of the body.
5. The FRP structural material according to any of claims 1 to 4, wherein a thickness of one core material is 20 mm or less.
6. The FRP structural material according to any of claims 1 to 5, wherein said FRP structural material has an FRP rib which extends in the thickness direction of said core material and which is combined integrally with said FRP skin layer.

7. The FRP structural material according to any of claims 1 to 6, wherein said core material comprises a foamed material

8. The FRP structural material according to any of claims 1 to 7, wherein a groove is formed for distribution of a resin when an FRP skin layer is formed on a surface of at least one sheet of said core material.

9. The FRP structural material according to claim 8, wherein a groove for resin distribution comprises a large groove and a small groove communicated with said large groove.

10. The FRP structural material according to any of claims 1 to 7, wherein a net-like material is disposed at a position adjacent to a reinforcing fiber substrate of an FRP skin layer, and said FRP skin layer, said net-like material and at least one sheet of a core material are integrally molded.

11. An FRP structural material wherein a pair of plates, at least one of which contains FRP, are disposed with a gap therebetween, and a rib structural material connecting both plates is interposed in the gap, characterized in that a seamless, enclosed hollow core material is contained in said gap.

12. The FRP structural material according to claim 11, wherein a dimension of said gap is varied in the extension direction of

said plates.

13. The FRP structural material according to claim 12, wherein at least one plate is formed as a folded plate in which a mountain part and a valley part are disposed alternately.

14. The FRP structural material according to any of claims 11 to 13, wherein said seamless, enclosed hollow core material comprises a blow molded product made from a thermoplastic resin.

15. The FRP structural material according to any of claims 11 to 14, wherein a volume of said seamless, enclosed hollow core material is 1000 cm³ or more.

16. The FRP structural material according to any of claims 11 to 15, wherein a matrix resin of FRP of at least one plate is a phenol resin.

17. The FRP structural material according to any of claims 11 to 16, wherein a groove is defined on at least one surface of said seamless, enclosed hollow core material.

18. The FRP structural material according to any of claims 11 to 16, wherein a net-like material is disposed at a position adjacent to a reinforcing fiber substrate of FRP of at least one plate, and said at least one plate, said net-like material and at

least said seamless, enclosed hollow core material are integrally molded.

19. The FRP structural material according to any of claims 11 to 18, wherein a thickness of said seamless, enclosed hollow core material is in the range of 0.5 mm to 5 mm.

20. The FRP structural material according to any of claims 11 to 19, wherein carbon fibers are contained as reinforcing fibers of FRP of at least one plate.

21. The FRP structural material according to claim 20, wherein said reinforcing fibers include a tow-like carbon fiber filamentary yarn of which filament number is in the range of 10,000 to 300,000.

22. The FRP structural material according to any of claims 11 to 21, wherein a fireproof material is provided on at least one surface.

23. An FRP structural material comprising a core material, an FRP plate disposed on at least one surface of said core material and an FRP reinforcing material disposed at least on one end portion of said core material and having a flange portion extending substantially in parallel to and a web portion extending substantially perpendicular to said FRP plate,

characterized in that a recessed portion, into which said flange portion of said reinforcing material is fitted, is defined on at least one surface of said one end portion of said core material, a groove communicating with said recessed portion and forming a resin path at the time of molding is defined on said core material, and said FRP plate, said FRP reinforcing material and said core material are integrally molded with a resin.

24. The FRP structural material according to claim 23, wherein said FRP structural material has a sandwich structure in which said FRP plate is disposed on each surface of said core material, and said reinforcing material extends between two FRP plates.

25. The FRP structural material according to claim 23 or 24, wherein said recessed portion is defined on each surface of said core material.

26. The FRP structural material according to any of claims 23 to 25, wherein said groove comprises a large groove and a small groove diverged from said large groove.

27. The FRP structural material according to claim 26, wherein the following relationship is satisfied.

$$(a) 200 \geq W \times H \geq 5 \text{ (mm}^2\text{)}, \quad (b) 300 \geq P \geq 100 \text{ (mm)}$$

Where, H is a depth of said large groove, W is a groove width and P is a pitch of the groove.

28. The FRP structural material according to claim 26, wherein the following relationship is satisfied.

$$(a) 100 \geq w \times h \geq 1 \text{ (mm}^2\text{)}, \quad (b) 100 \geq p \geq 5 \text{ (mm)}$$

Where, h is a depth of said small groove, w is a groove width and p is a pitch of the groove.

29. The FRP structural material according to any of claims 23 to 28, wherein said reinforcing material is disposed discontinuously in a surface direction of said FRP plate.

30. The FRP structural material according to any of claims 23 to 29, wherein a share strength between said flange portion of said reinforcing material and said FRP plate is not less than a tensile strength of said flange portion of said reinforcing material itself determined in the share direction thereof.

31. The FRP structural material according to any of claims 23 to 29, wherein a length of said flange portion of said reinforcing material "a" satisfies the following equation.

$$\begin{aligned} \max (\sigma_2 \times t_2, \sigma_s \times t_s) &\geq K \tau a \\ &\geq \min (\sigma_2 \times t_2, \sigma_s \times t_s) \end{aligned}$$

Where, σ_2 is a tensile strength of the flange portion,

t_2 is a thickness of the flange portion,

σ_s is a tensile strength of the FRP plate,

t_s is a thickness of the FRP plate,

τ is a share strength between the flange portion and

the FRP plate,

K is a valid efficiency of connection,

"max" shows the greatest value in the parenthesis, and

"min" shows the smallest value in the parenthesis.

32. The FRP structural material according to claim 31, wherein a value of the product by the tensile strength σ_2 and the thickness t_2 of said flange portion of said reinforcing material is not more than a value of the product by the tensile strength σ_s and the thickness t_s of said FRP plate, and the length "a" of said flange portion satisfies the following equation.

$$\sigma_s \times t_s / \tau \geq K a \geq \sigma_2 \times t_2 / \tau$$

33. The FRP structural material according to any of claims 23 to 29, wherein a length of said flange portion "a" and a length of said web portion "b" of said reinforcing material satisfy the following equation.

$$a / a_0 = K (b / b_0) [(t_2 / t_{20}) / (t_1 / t_{10})]^2$$

Where, t_1 is a thickness of the web portion,

t_2 is a thickness of the flange portion,

the attached character 0 is a standard value set up depending on a molding condition, and

K is a proportional constant.

34. The FRP structural material according to any of claims 23 to 29, wherein a length of said flange portion "a" and a length

of said web portion "b" of said reinforcing material satisfy the following equation.

$$a / a_0 = K (b / b_0) (t_s / t_1 + 1)^2$$

Where, t_1 is a thickness of the web portion or the flange portion,

t_s is a thickness of the FRP plate,

a_0 and b_0 are standard values set up depending on a molding condition, and

K is a proportional constant.

35. An FRP structural material characterized in that an FRP layer is disposed on at least one surface of a core material comprising from a foaming material, said core material being molded by foaming in a mold with a pattern for defining a predetermined groove and said core material having a groove defined at the same time as molding on at least one surface of said core material.

36. The FRP structural material according to claim 35, wherein reinforcing fibers of said FRP layer include a tow-like carbon fiber filamentary yarn of which filament number is in the range from 10,000 to 300,000.

37. A structural material characterized in that a core material, a net-like material disposed on a surface of said core material, and a layer containing a reinforcing fiber substrate disposed on

said net-like material are disposed in this order, and these materials are molded integrally.

38. The structural material according to claim 37, wherein said layer containing said reinforcing fiber substrate comprises an FRP layer.

39. The structural material according to claim 37, wherein said layer containing said reinforcing fiber substrate comprises a fiber reinforcing inorganic material layer.

40. The structural material according to any of claims 37 to 39, wherein a thickness of said net-like material is 3 mm or less.

41. The structural material according to any of claims 37 to 40, wherein a groove is defined on said core material for forming a resin path at the time of molding.

42. The structural material according to any of claims 37 to 41, wherein reinforcing fibers of said reinforcing fiber substrate include a tow-like carbon fiber filamentary yarn of which filament number is in the range of 10,000 to 300,000.

43. The structural material according to any of claims 37 to 42, wherein said core material is formed as a hollow material.

44. The structural material according to claim 43, wherein said core material is formed from a plastic, a rubber or a thin metal.

45. The structural material according to claim 43 or 44, wherein said core material has a circular or rectangular cross section.

46. The structural material according to any of claims 43 to 45, wherein a foaming material is filled up in said core material.

47. A process for manufacturing an FRP structural material characterized in that a plurality of core materials are stacked, a reinforcing fiber substrate is disposed on at least one surface of said core material, and said reinforcing fiber substrate is impregnated with a resin.

48. The process for manufacturing an FRP structural material according to claim 47, wherein a reinforcing fiber substrate is interposed into at least a part of a portion between stacked core materials.

49. The process for manufacturing an FRP structural material according to claim 47 (or 48), wherein a groove is defined on a surface of a core material in contact with a reinforcing fiber substrate, and a resin is distributed along said groove as well as the resin is impregnated into the reinforcing fiber substrate.

50. The process for manufacturing an FRP structural material according to claim 47 (or 48), wherein a net-like material is disposed between a core material and a reinforcing fiber substrate, and a resin is distributed along said net-like material as well as the resin is impregnated into the reinforcing fiber substrate.

51. The process for manufacturing an FRP structural material according to any of claims 47 (to 50), wherein, after at least a portion disposed with a reinforcing fiber substrate is covered with a bag substrate, the inside covered with said bag substrate is evacuated, and a resin is injected to impregnate the resin into the reinforcing fiber substrate.

52. The process for manufacturing an FRP structural material according to any of claims 47 (to 51), wherein a reinforcing fiber substrate extending in the thickness direction of the core material is disposed, and an FRP rib is formed by impregnating a resin into said reinforcing fiber substrate.

53. A process for manufacturing an FRP structural material characterized in that reinforcing fibers are disposed on a mold, a seamless, enclosed hollow core material wound with reinforcing fibers at a predetermined position is disposed on said reinforcing fibers disposed on said mold, reinforcing fibers are further disposed thereon, and after the whole of the materials is

covered with a film substrate for vacuum, the inside covered with said film substrate is evacuated, and a resin is injected to impregnate the resin into reinforcing fibers.

54. The process for manufacturing an FRP structural material according to claim 53, wherein said seamless, enclosed hollow core material is formed by blow molding.

55. A process for manufacturing an FRP structural material formed from an FRP composed of a reinforcing fiber substrate and a matrix resin, characterized in that, when a portion not impregnated with a resin is found on a surface, after the whole of the resin non-impregnated portion and its vicinity is entirely covered with a bag substrate, the inside covered with said bag substrate is evacuated, and a resin is injected into the inside to impregnate the resin into the resin non-impregnated portion of said reinforcing fiber substrate.

56. The process for manufacturing an FRP structural material according to claim 55, wherein the whole of said resin non-impregnated portion is covered with said bag substrate after a resin distribution medium is disposed on said resin non-impregnated portion.

57. The process for manufacturing an FRP structural material according to claim 56, wherein a resin permeable mold separation

material is interposed between said resin distribution medium and said reinforcing fiber substrate with said resin non-impregnated portion.

58. A process for manufacturing an FRP structural material, characterized in that a core material having a recessed portion defined on at least one surface of one end portion, a reinforcing fiber substrate extending in the surface direction of the core material on at least one surface of said core material, and a substrate for forming a reinforcing material having a flange portion substantially extending in parallel to said reinforcing fiber substrate and positioned in said recessed portion and a web portion substantially extending perpendicular to said reinforcing fiber substrate, are disposed in a mold, a medium for distributing a resin in its surface direction is disposed above, or above and below these disposed materials and substrate, or a resin distribution path for distributing a resin in the surface direction of said core material is defined on said core material, and then, after the whole is covered with a bag film, the inside covered with the bag film is evacuated, a resin is injected and distributed along the surface of said reinforcing fiber substrate and the resin is impregnated into said reinforcing fiber substrate, thereby said reinforcing fiber substrate, said substrate for forming a reinforcing material and said core material are integrally molded by the resin.

59. The process for manufacturing an FRP structural material according to claim 58, wherein said substrate for forming a reinforcing material also comprises a reinforcing fiber substrate.

60. The process for manufacturing an FRP structural material according to claim 58, wherein said substrate for forming a reinforcing material comprises a preformed FRP substrate.

61. The process for manufacturing an FRP structural material according to any of claims 58 (to 60) wherein a reinforcing fiber substrate is disposed on each surface of said core material, and a substrate for forming a reinforcing material is disposed so as to extend between both reinforcing fiber substrates.

62. The process for manufacturing an FRP structural material according to any of claims 58 (to 61) wherein a resin distribution path of said core material is communicated with said recessed portion, and said substrate for forming a reinforcing material is integrally molded by introducing said injected resin into the recessed portion.

63. A process for manufacturing an FRP structural material, characterized in that a core material with a groove is molded by foaming a foaming material in a mold with a pattern for forming a predetermined groove, a reinforcing fiber substrate is disposed

on at least one surface of the molded core material with a groove, and after the whole is covered with a bag substrate, the inside covered with said bag substrate is evacuated, and a resin is injected and distributed along the surface of said reinforcing fiber substrate via said groove of said core material while the resin is impregnated into said reinforcing fiber substrate in the thickness direction of said reinforcing fiber substrate, thereby said core material and said reinforcing fiber substrate are integrally molded by the resin.

64. A process for manufacturing an FRP structural material, characterized in that a core material, a net-like material disposed on at least one surface of said core material, and a reinforcing fiber substrate provided on said net-like material are disposed in this order, and after the whole is covered with a bag film, the inside covered with the bag film is evacuated, and a resin is injected and distributed along the surface of said reinforcing fiber substrate via said net-like material, the distributed resin is impregnated into said reinforcing fiber substrate, thereby said core material, said net-like material and said reinforcing fiber substrate are integrally molded by the resin.

65. The process for manufacturing an FRP structural material according to claim 64, wherein a groove for a resin path is defined on said core material, and an injected resin through said

groove is distributed to each part of said net-like material.

66. The process for manufacturing an FRP structural material according to claim 64 or 65, wherein a hollow core material is used as said core material.

67. The process for manufacturing an FRP structural material according to any of claims 64 (to 66), wherein said reinforcing fiber substrate is disposed over the entire circumference of said core material.